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THE BLACK-ROT OF THE GRAPE, AND ITS
CONTROL



BY
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I. THE FUNGUS THAT CAUSES BLACK-ROT OF GRAPES.

BY DONALD REDDICK.

While black-rot has been present in New York for a long time, during the past few years losses from this source have been increasing. In the period from 1904 to 1906 they were very heavy, amounting to an entire failure in many localities. Recognizing the serious nature of the trouble and giving heed to the earnest request of certain large growers, a thorough investigation of the nature of this disease has been instituted at this Station. These pages are in the nature of a preliminary report on the progress of the work. The facts here recorded have been observed during the past year, at the special field station located at Romulus, N. Y., and have been confirmed by observations in other localities. No claim is made to originality for indeed most of the observations recorded here have been published at some time by various investigators in other State Experiment Stations, notably by Scribner and later Galloway, U. S. Department of Agriculture; Chester in Delaware; Price in Texas; Selby in Ohio; and others.

It is a function of all plants to reproduce themselves and thus perpetuate and propagate the species. This function is performed by the plants with which we are best acquainted, by means of seeds. The seed is a resting stage and serves to carry the plant through the winter.

There are, however, a very large number of plants known to the casual observer only by the effect they produce. This is because of their small size and the necessity of a microscope to examine and study them. They, however, are similar to other plants in that they produce a winter or resting stage, the unit of which is called a *spore*. Among this large number of microscopic plants is a group known as fungi. It is to this group (many of them parasites), that we may attribute a large number of the diseases of cultivated plants as well as some of those of animals.

Nature of black-rot.

The black-rot of grapes is caused by a fungus which lives as a parasite on the green parts of the vine and fruit, thus sapping the vitality of the vine and often destroying all the fruit. This fungus (*Guignardia*

bidwellii) produces its winter or resting stage on the black hard mummied grape berry or its pedicel (Fig. 177). Its spores are contained in tubular sacs, each sac or *ascus* containing 8 spores. A large number of the sacs (20-50) are grouped close together and surrounded by several layers of

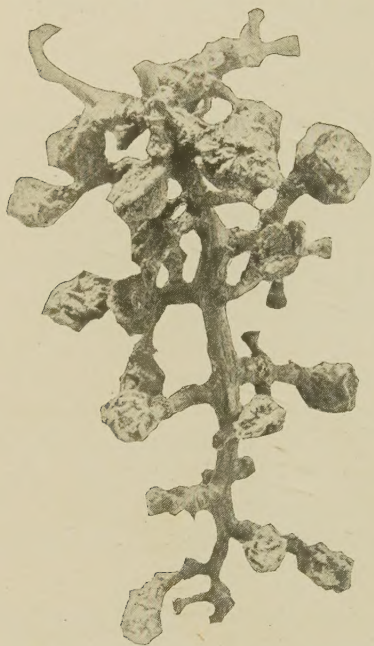


FIG. 177—The mummy berries, on which the fungus passes the winter.

thick-walled cells. Protection is thus assured for the spores or germs. This cluster of sacs with their thick protection appears to the naked eye as a very small pimple on the surface of the mummied berry. Every berry may have a hundred or more such pimples, which are technically known as *perithecia*. (See Fig. 178.)

Some of the spores are ripe and ready to grow about the time the first three or four leaves on the new shoots appear. Others do not ripen until later. If the first fail to start the disease, those produced later will.

This succession of maturity of spores is such that as late as October winter-spores just in condition to grow can be found. This at least was true during the past season, which was very dry. The fungus, just as any field crop, must have moisture in order to grow.

The accompanying illustration (Fig. 178) is of a thin section through the middle of the perithecium, taken at a stage when only a few of the sacs have mature spores. In the others, the spores are not yet formed. The section is greatly magnified and shows the condition when water is added. In the vineyard, this would mean whenever rain or dew lodged on the mummied berry. The sacs that contain ripe spores become gelatinous and, being swelled by the addition of water, protrude themselves beyond the wall of the perithecium. For this reason, poisonous substances sprayed on the mummies are not effective, since they do not touch the germs.

Distribution of the germs.

Now a most interesting thing, as seen under the microscope, takes place. The spores are crowded to the upper end of the ascus and the one at the tip can be seen to be moving. It is as though the spore

which is widest at the middle, were trying to squeeze through a tight place. At first, it moves slowly, but eventually the widest part passes the constriction and the spore is snapped into the air. It is often thus discharged for a distance of more than a centimetre ($\frac{1}{2}$ inch). The next spore is pushed up and follows closely after the first, so that all eight spores may be discharged into the air in the course of ten minutes.

Critical stage.

Now comes the most critical stage for the fungus. In order to continue its existence the spore must fall upon some green part of the vine, either stem, tendril, leaf, or young cluster. The only plant, other than the grape, on which it is known to grow is the Virginia creeper or 5-leaved ivy. It will not grow on weeds, grass, posts, wires, or on any dead material except by careful nursing in the laboratory. If the cluster of mummies is clinging to the vine, it is easy for the spores to fall down and lodge on a leaf or even be blown across to other vines. Most of the mummied berries,

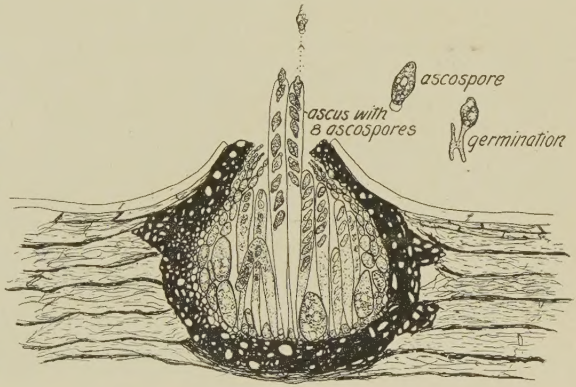


FIG. 178—Diagrammatic section of a perithecium containing winter-spores. The spores do not all mature at the same time. Germination of the spores can be seen at the right. (Greatly magnified.)

however, are knocked off in pruning and are lying on the ground. The fungus is therefore largely dependent on the wind to blow the spores to the leaves or fruits, and for this reason a comparatively small number ever survive.

Infection.

The spore that lodges upon a green part of the vine must have a drop of water, though it may be very small, in which to germinate and grow. Germination rarely takes place in less than 36 hours. In 36 to 48 hours a small bud or protrusion (germ tube) appears on one side, see (Fig. 178), and as it grows the tip makes its way through the surface of the leaf or

green stem. Growth of the tube continues by the absorption of sap and other food material from the vine. The fine thread-like tube branches and spreads out for a short distance on the inside. Cross-walls are now formed and the growth is known as *mycelium*. The mycelium is the vegetative or growing stage of the fungus and, although rarely seen, is the stage which does the great damage. The threads not only push between the cells of the grape and in that way absorb the sap which would normally flow from one cell to another, but also penetrate directly into the cell and take up food material there. When the mycelium has established itself on the inside and can no longer be prevented from grow-

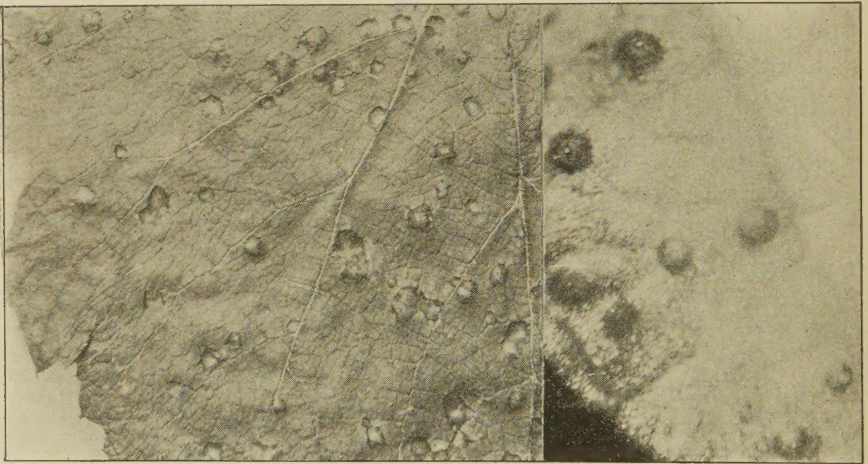


FIG. 179—On the left, black-rot spots on the leaf (natural size); on the right, photomicrograph of a small portion of a single spot showing fruit bodies of the fungus.

ing or be killed by means of a poisonous spray, *infection* is said to have taken place; the leaf or vine is infected.

Incubation.

The mycelial threads grow for a short distance in all directions from the point of infection; never as much as an inch and usually not more than $\frac{1}{8}$ to $\frac{1}{4}$ inch. This growth takes place rather slowly and there is no external evidence of it until 12 to 20 days after infection took place. This time is known as the *period of incubation*. At the end of this time the diseased area changes color and that part of the leaf becomes yellowish brown in color. (See Fig. 179).

Pycnidia.

The mycelium serves the treble purpose to the fungus of root, stem and leaf. It alone develops a receptacle in which reproductive bodies are produced, while the root, stem and leaf of the stalk of corn all contribute to the production of an ear (seed). The fruiting bodies of the fungus that contain the summer spores (Fig. 180) are formed of very short interwoven branches of the mycelium which become thick-walled and black, and are

known as *pycnidia*.

There is a small circular opening at the top. The pycnidia form a more or less concentric ring on the spot and there are from 5 to 30 or more of them on a single spot, visible to the naked eye as very small pimples. The

interior of each pycnidium is lined with a layer of delicate club-shaped bodies. These are specialized mycelial threads, and the summer-spores or *pycnospores* are formed on their tips. Summer-spores are formed in this way until the pycnidia become filled with them.

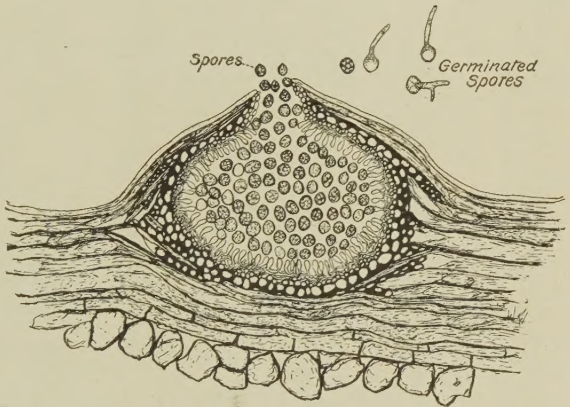


FIG. 180.—Diagrammatic section through a single pycnidium, showing how the summer-spores are produced and how they germinate. (Greatly magnified.)

Summer-spores.

These spores are surrounded by a gelatinous substance. When a drop of water is placed on a ripe pycnidium, this gelatinous substance swells and the pycnospores are forced out through the hole in the top in a fine white thread-like stream. (Fig. 180). The pycnospores germinate in water in 18 to 24 hours, grow, form a new mycelium and produce exactly the same effect as the winter-spores. They also have the particular advantage of being on the leaves or stems and later on the berries from which the wind may carry them for considerable distance to other vines.

Stages of infection.

In Fig. 181 are shown the spots formed by the first infection of 1907 on stem, leaf, leaf petiole and tendril. These spots are frequently overlooked by the grower. To many, the first signs of the black-rot is the blackening of the pedicel of the berry. This, however, is only one of the many points of first infection. The little berry is protected by the calyx

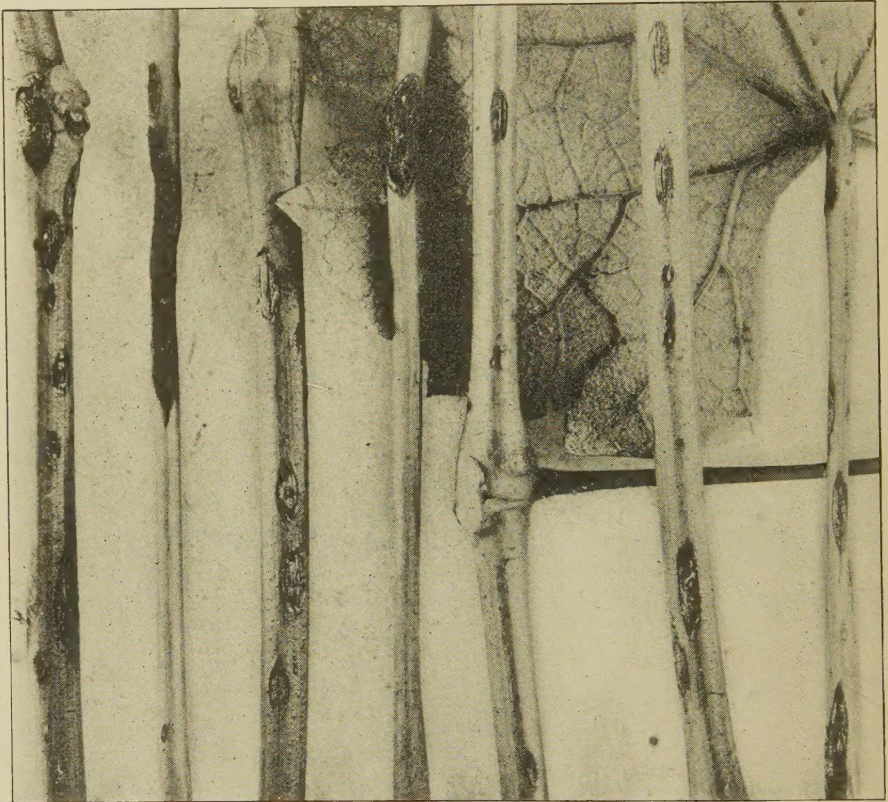


FIG. 181—*Black-rot fungus on the canes, showing as pits and blotches.*

which falls off at blooming time while its pedicel is not so protected; but as the source of sap is cut off the berry fails to develop.

In the vineyards at Römulus in 1907, the first infection from winter-spores took place with the rain of June 22nd and 23rd, which was followed by showers and cloudy weather. The first spots appeared July 10th. The period of incubation was thus from 16 to 18 days. The second

infection from winter-spores took place June 30th and the 48 or 60 hours of cloudy and rainy weather following. The spots appeared July 17th and later. The vines were in full bloom June 28th and no doubt some of the small berries were infected at this time, though the number was comparatively small. The third infection took place from ascospores also, for no pycnospores were mature at this time, and proved to be more abundant on berries than any place else. The ascospore, if it has the moisture, will penetrate the berry just as it did the leaf. The infection came with the gentle rains of the 11th and 12th of July, and the first external indications appeared on July 21st and 22nd.

Period of incubation.

The period of incubation in the juicy berry is usually from 8 to 14 days at the end of which time a small circular, whitish spot 1 to 2 mm

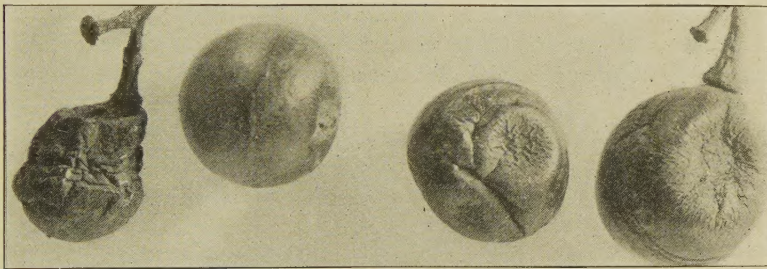


FIG. 182—Showing stages in the rotting of the fruit

(1-12 in.) in diameter, appears. This enlarges rapidly and in 48 to 60 hours may involve half of the berry. About this time a blackening appears at the center of the spot. This is caused by the formation on the mycelium and just under the cuticle of the berry of a large number of pycnidia. These form very rapidly and in 24 hours more than half of the berry may have turned black. Thus it is that one frequently hears it said, "the whole vineyard rotted down in a day."

Black-rot on the berry.

It occasionally happens that the effect on the berry is much like that on the stem, so that a black crust is formed only on one side of the berry. Usually, however, the whole berry is involved. By the time the whole berry has become discolored, wrinkles are appearing on the side first attacked and eventually the berry becomes wrinkled and black and dry. (Fig. 182). The pycnidia are very numerous on these mummified berries

and they contain great quantities of pycnosporos which with another rain and favorable weather produce another infection. And so it is that during the entire season following every rain there is a new infection which becomes evident on the berries about ten days or two weeks later. If the conditions are right, the berry will be infected at any stage up to the time it is ripe and ready to pick. The rot does not go from one berry to another except by means of spores.

The effect of dry weather.

The remainder of the month of July, 1907, after the 12th, and most of August was very dry. Very few infections took place during this period. There was an enormous number of pycnosporos formed in the pycnidia on the rotted berries and on other parts of the vine but for want of moisture these remained in the pycnidia, protruding slightly and forming a white speck at the apex.

With the rapid growth of the healthy berries the opening in the cluster, caused by the drying up of some berries from black rot, soon fills. In some cases, it is just as well that some of the berries be removed but in the case of a light setting, every berry that rots represents an actual loss, to say nothing of the danger of spreading the disease to other berries. It very frequently happens that as much as 25% of the crop may disappear in this way without attracting the attention of the grower.

Preparation for winter.

When the pycnosporos are discharged from the pycnidia, the latter become entirely filled with whitish cells and remain through the winter in this way. In the spring these cells elongate to form the ascus, and the whitish content breaks up to form the eight spores.

Other sources of infection.

It frequently happens that pycnosporos formed on the berries in the autumn have thicker walls and are not discharged from the pycnidia. They lie thus through the winter and the following spring are discharged and produce an infection. It also happens that the pycnosporos are not discharged from some of the pycnidia on the tendrils or stems. These live and are capable of producing an infection.

With the above facts in regard to the life-history of this fungus, the reasons for the recommendations at the end of this bulletin will become apparent. Further information in regard to any of these points will be gladly furnished by addressing an inquiry to the Department of Plant Pathology, New York State College of Agriculture, Ithaca, N. Y.

II. THE CONTROL OF BLACK-ROT.

Under the direction of Professor JOHN CRAIG.

BY C. S. WILSON.

EXPERIMENTS OF 1906.

Three experiments were conducted by the Department of Horticulture under the direction of Professor Craig. The purpose of these experiments was to study the effectiveness of different fungicides for controlling the black-rot. They were conducted in the vineyards of the Niagara Grape Company at Romulus, N. Y., which are under the superintendency of Mr. G. G. Lansing; in the vineyards of Mr. H. H. Bradley, King Ferry; and Mr. M. E. Sperry, Ludlowville.

The vineyard of the Niagara Grape Company is situated about two miles from the west side of Cayuga Lake. The land slopes slightly to the east. The soil is a rich clay loam, and for several years the vineyard has been well cultivated. The vines are about twenty years old, and had been well sprayed previously. In 1905, black-rot destroyed the entire crop. The variety is Niagara.

Mr. Bradley's vineyard is situated on the east side of the lake at King Ferry. The land slopes sharply to the west. The soil is a sandy or gravelly loam, and has been well cultivated. The vines are nineteen years old. Since the black-rot has not yet seriously affected the vineyard, it has been sprayed for two or three years only. In 1905, portions only and not the whole vineyard were affected. In the experimental plat the variety is Catawba.

Mr. Sperry's vineyard is on the east side of the lake at Ludlowville. The land slopes sharply to the west. The soil is a gravelly loam. For the last four years the vineyard has been poorly cared for, and the vines have not been sprayed. In 1905, the black-rot destroyed nearly the entire crop. The variety is Concord.

No accurate results were obtained from Mr. Sperry's vineyard. The grapes rotted badly, burst open early, and were picked before the yields were computed. The results as shown by field notes substantiate in a general way the findings secured in the other two vineyards.

A plat or block was chosen in each vineyard, all parts of which plat were under nearly uniform conditions. Thirteen rows, each twenty to twenty-five rods long, were selected and treated as follows:

1. Check (unsprayed).
2. Bordeaux, 5-4-40 + sulphur 6 lbs. to 40 gals.
3. " " " 4 " "
4. " " " 2 " "

5. Check.
6. Bordeaux, 5-4-40, (two applications). Ammoniacal copper carbonate (three applications).
7. Bordeaux (five applications).
8. " (four ").
9. " (three ").
10. Check.
11. Bordeaux, 6-4-40.
12. " 4-4-40.
13. Check.

Each plat was sprayed five times as follows:

Niagara Grape Company	H. H. Bradley
1st. April 21st to 27th.	May 12th.
2nd. May 24th.	June 22nd.
3rd. June 6th.	July 10th.
4th. July 11th.	Aug. 7th.
5th. Aug. 20th.	Aug. 17th.

Probably the vines were more thoroughly sprayed than they would be by the commercial vineyardist, yet not more thoroughly than would be practicable for him.

The appearance of the disease was first noticed in the vineyard of the Niagara Grape Company on June 23rd, at which time it was prevalent in the form of small round spots on the leaves. No trace of it was as yet visible on the berries. On June 30th, it was found on the berries, which at that time varied in size from that of a radish seed to a small pea. On July 1st, probably five per cent of the clusters on each vine showed a little rot. The diseased berries were not confined to the tip, but appeared on any part of the bunch.

From this time, the disease spread very rapidly, and on July 17th a very general outbreak which practically ruined the entire crop appeared. Probably, there was not one bunch in a thousand that was not affected. After July 17th, the rot spread very little, and very slowly. This condition continued until the fruit ripened. In the vineyard of Mr. Bradley, it appeared at a later date, and was less violent.

Two methods were employed to compute the results, one based on the number of the clusters, the other on the weight of the fruit. As time would not permit the Experiment Station men to pick the fruit from the entire plat, cross sections were selected in which conditions were as uniform as possible. In the vineyard of the Niagara Grape Company two sections were chosen; in the vineyard of Mr. Bradley, three. The entire crop was picked from these sections, and the clusters sorted into

grades, usable and nonusable. These grades were arbitrarily chosen. Under the head of usable, were classed those bunches of which the majority of berries were sound. Some bunches were nearly perfect; others contained a few rotted berries. One could scarcely call the fruit of this grade marketable.

As non-usable, were classed the remaining clusters of which the majority of berries had rotted. The number of usable and non-usable clusters was counted in every case. Each grade was also weighed.

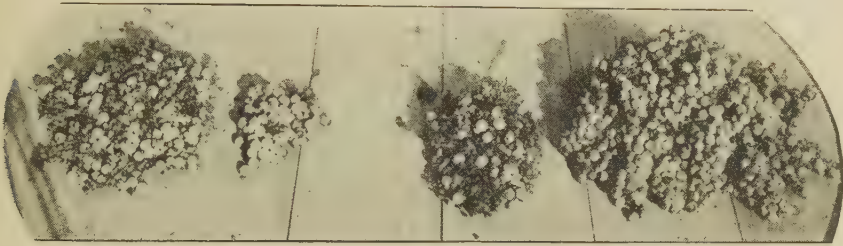


FIG. 184—Fruit from sprayed and check rows.

From left to right:

1. Non-marketable fruit from check row.
2. Marketable fruit from check row.
3. Non-marketable fruit from sprayed row.
4. Marketable fruit from sprayed row.

In the case of the Niagara Grape Company, the fruit that remained on the vines after the Experiment Station men had computed their results was picked by Mr. Lansing himself. This was taken to the packing house and graded by the packers. A record was made of the number of pounds picked from each row.

The results in tabular form are given below:

	No. lbs. of fruit packed for market	Niagara Grape Co.				H. H. Bradley's.			
		Clusters		Weight		Clusters		Weight	
		Usable %	Non-Usable %	Usable %	Non-Usable %	Usable %	Non-Usable %	Usable %	Non-Usable %
1. Check.....	6½	27	73	55	45	24	76	47	53
2. Bor.-sulphur 6 lbs.....	8½	59	41	81	19	73	27	87	13
3. " 4 ".....	103½	68	32	88	12	82	18	90	10
4. " 2 ".....	118½	78	22	92	8	84	16	92	8
5. Check.....	1	18	83	40	60	40	60	66	34
6. Bor. 2 ap. A. C. C. 3 ap.....	99	79	21	87	13	70	30	84	16
7. " 5 applications.....	61	70	30	84	16	86	14	93	7
8. " 4 ".....	84	62	38	84	16	81	19	93	7
9. " 3 ".....	65	65	35	79	21	77	23	87	13
10. Check.....	3	97	12	88	43	57	67	33	67
11. Bor. 6-4-40.....	46	62	38	86	14	81	19	92	8
12. " 4-4-40.....	36	34	66	60	40	87	13	94	6
13. Check.....	½	20	80	31	69	50	50	64	36

Deductions from the experiments of 1906

1. Unsprayed rows yielded no marketable fruit.
2. No striking differences were shown by the different sprays.
3. The addition of sulphur did not increase the efficiency of the spray to a noticeable degree.
4. The best results were secured with Bordeaux, 5-4-40, + sulphur 2 lbs. to 40 gals.
5. Spraying after the rot appeared apparently did not affect its spread.
6. The foliage was much healthier and freer from disease on the sprayed rows.
7. The rot was worse on fruit in the immediate vicinity of dried clusters of previous years. This emphasizes the necessity of removing all dried clusters or other means by which the disease may be carried over winter.
8. A normal yield for one row in the vineyard of the Niagara Grape Company approximated 400 pounds. The largest yield from any sprayed row in the same vineyard amounted to 132 pounds. This represented a loss of sixty-seven per cent caused by the rot, or a saving of thirty-three per cent caused by the spraying. While this is unsatisfactory from the standpoint of effective protection, yet the thirty-three per cent. saved much more than paid for the operation. It is a question, however, if grape-growing could be conducted with profit on this basis, counting expenses and interest on investment.

On the other hand, in the vineyard of Mr. H. H. Bradley, fully eighty per cent of the crop was saved, the loss amounting to about twenty per cent only. Spraying, therefore, with Mr. Bradley proved of great commercial value.

EXPERIMENTS OF 1907.

The work of 1906 showed marked results in favor of spraying. The experimenters, however, did not feel that the problem was solved for the commercial grower. Work on a larger scale must be done, and the results computed from the standpoint of the grower. Such work was undertaken in the year 1907. A plat of ten acres was chosen in the vineyard of the Niagara Grape Company. The experiment was planned and conducted with the greatest care consistent with the scale on which the work was carried out. If the rot could be controlled by spraying, the experimenters were determined to control it. The map shows the general plan of the work.

ROW NUMBER		PLAT NUMBER
1		
2-6	Bordeaux, 5-5-50; resin sal-soda sticker	1
7-11	Bordeaux, 5-5-50; resin fish-oil soap sticker	
12		
13-17	Sprayed and treated as Mr. Lansing treated vineyard	2
18-22	in 1906. (See following paragraph)	
23		
24-28	Bordeaux, 5-5-50; clusters bagged	3
29-33	Bordeaux, 5-5-50; clusters not bagged	
34		
35-39	Bordeaux, 5-5-50; clingers burned	4
40-44	Bordeaux, 5-5-50; clingers not burned	
45		
46-50	Bordeaux, 6-6-50.	5
51-55	Bordeaux, 6-6-50.	
56		
57-61	Bordeaux, 5-5-50.	6
62-66	Bordeaux, 5-5-50.	
67		
68-72	Bordeaux, 4-4-50.	7
73-77	Bordeaux, 4-4-50.	
78		
79-83	Check	8
84-88	Iron sulfate, 5-5-50.	
89		
90-94	1st application, lime and sulfur; others, Bordeaux	9
95-99	1st application, copper sulfate solution; others, Bordeaux	
100		

The plat consisted of 100 rows, 53 vines per row, vines 10 feet apart, rows 9 feet. The area was divided into nine different plats, with one check row between each plat. Each plat was again divided into two parts. The purpose of such division was to test a few of the less important treatments in view of suggestions for future work, and also to make the tests comprehensive. The map, therefore, is made with such divisions, and the results are tabulated accordingly. The treatment of Plat 2 (sprayed and treated exactly as Mr. Lansing did last year) is as follows:



FIG. 184—A good grape hoe.

The soil is plowed from the rows in the spring, and the rows worked with the grape hoe. No further treatment is given until July, when the soil is plowed back to the row, and left until the following spring. The vines are sprayed three times: First, before the buds swell; second, before the blossoms open, third, after the blossoms fall. At each spraying two small Vermorel nozzles were used on each side of the machine, one nozzle for each wire. Plat 1 received the same cultivation as Plat 2.

The rest of the plats were sprayed as follows:

First, May 3-9.

Second, June 7-8.

Third, June 26-27.

Fourth, July 9-10.

(Note: Rows 35-44 also sprayed July 16).

Fifth, July 23-24.

Sixth, Aug. 5-6 (Ammoniacal copper carbonate on all plats except check and No. 2).

Seventh, Aug. 20-21 (Ammoniacal copper carbonate same as above).

Cultivation.—Plats 3, 4, 5, 6, 7, 8, 9 were plowed in the spring. The soil was thrown from the rows. The grape hoe was used to cultivate between the vines, and following this for clean work, the hand hoe. The furrows were then cut with a cutaway harrow. The spring-tooth harrow followed this, leaving the ground level and mellow. Cultivation was



FIG. 185—Vineyard sprayer used in the experiment, showing stationary nozzles at side: also trailers with extension rod.

continued on these plats until about the middle of July when cover-crops were sown as follows:

Rows	24-28 crimson clover.....	July	16
"	29-33, vetch.....	"	16
"	35-39, crimson clover	"	16
"	40-44, vetch.....	"	16
"	46-50, mammoth clover.....	"	24
"	57-61, crimson clover	"	24
"	90-99, buckwheat	"	24

The latter part of the summer was dry, and the cover-crops did not grow well. Vetch and buckwheat did the best, with crimson clover third.

The appearance of the rot.

On the night of Thursday, July 10, the rot was first discovered on the leaves. It was almost entirely on the suckers at the base of the vines,

and appeared as small spots mostly on the upper surface of the leaf. On Monday night, July 15, the first rot was found on the berries. This appeared to be a small epidemic. More rot showed Tuesday morning. On sprayed rows, it was necessary to hunt to find a rotted berry. On unsprayed rows the rot was more evident. For about a week, the berries continued to rot slightly. On July 22, another slight epidemic began when a number of the berries rotted. One could find a handful in walking along a row. Following this was a period of dry weather during



FIG. 186—A cover-crop of buckwheat.

which very little rot appeared. Another small epidemic seemed to sweep over the vineyard about the 20th of September.

The grapes were picked October 10-17. All the fruit was picked from each plat and weighed, giving total weight. Grapes were then run through the packing house and graded, the weight of the commercial grade, and the weight of the culls being obtained. From these weights the percentages were computed. They are given in the following table:

TREATMENT		Total weight grapes	Weight commercial grade	Weight culls	Per cent commercial
PLAT		lbs.	lbs.	lbs.	%
1	Bordeaux, 5-5-50; resin sal-soda sticker.	2541	2116	425	83
	“ 5-5-50; fish-oil soap sticker..	1938	1566	372	76
2	Same as Mr. Lansing's treatment in 1906.	2494	2070	424	83
	Same as Mr. Lansing's treatment in 1906.	2494	2070	424	83
3	Bordeaux, 5-5-50; clusters bagged.....	2298	2186	112	95
	“ 5-5-50; clusters not bagged..	2318	1620	698	70
4	“ 5-5-50; clingers burned.....	2403	2238	165	93
	“ 5-5-50; clingers not burned..	2306	2034	272	88
5	“ 6-6-50	2543	2218	325	87
	“ 6-6-50	2133	2028	105	95
6	“ 5-5-50	2988	2848	140	94
	“ 5-5-50	2275	2111	164	93
7	“ 4-4-50	2853	2660	193	93
	“ 4-4-50	2854	2660	194	93
8	Check.....	2217	1554	663	70
	Iron sulfate, 5-5-50.....	2181	1713	470	78
9	First application, lime and sulphur; others Bordeaux.....	2416	2304	112	95
	First application, Cu SO ₄ , solution; others Bordeaux.....	2540	2010	530	79
10	10 Check rows=1 Plat.....	4360	2890	1471	66

COST AND RETURNS.

The yield of commercial grapes per acre from an average of four acres well sprayed.....	4770 lbs.
Check.....	3108 “
Gain.....	1662 lbs.
at 2½ cents per pound.....	\$41.55
Cost of material and labor for spraying.....	8.60
Saved per acre.....	\$32.95

The season of 1907 was comparatively dry, and not favorable to the development of the disease. In spite of this fact, good results were obtained which show that, when the rot is prevalent to a moderate degree, spraying will completely control it. We see from this table that all sprayed rows had very little rot, whereas the loss in the case of the check rows was 34 per cent and in the case of the check plat 30 per cent to say nothing of the extra labor of handling the poorer grades. Plats 4, 5, 6,

and 7, which were well sprayed and cultivated, averaged only 8 per cent. loss.

Iron sulfate mixture gave a loss of 22 per cent or a saving of 8 per cent over the check plat. One could detect very little difference between the plat sprayed with iron sulfate and the check plat. This mixture appears to be ineffective—in fact, little better than nothing—in controlling the rot.

The results obtained by burning the clingers are quite marked. It is a question, however, whether it pays on a commercial scale. The work was done with a large torch, made by the Pearsall Manufacturing Co., Texas. The principle of the torch is the same as that of a plumber's torch, except larger. It required one gallon of gasoline to burn the clingers from one row of fifty-three vines, and working only on one side of the trellis. Undoubtedly most spores were destroyed, but a few escaped. More satisfactory work could be done by using an ordinary plumber's torch and burning on both sides of the trellis. The burning of clingers is not recommended for commercial work.

The effect of spraying and cultivation on the health of the vine and maturity of the fruit was very marked. At the time of picking, the foliage on the experimental plat was green and healthy. Very little had fallen from the vines, whereas the foliage on other parts of the vineyard which were not well cultivated nor as thoroughly sprayed had mostly fallen. The few that remained were yellow and ripe. Practically, it is desirable to have an abundance of foliage in the fall. In case of frost, the foliage acts as a protection.

The fruit on the experimental plat ripened the earliest of any on the whole vineyard of 150 acres. They were sweeter than elsewhere, and could be picked first. As to the cause of this, the writer will not attempt to make a positive statement. It is his opinion, however, that it was the result of cultivation more than spraying.

The result of work at Penn Yan.

A demonstration experiment to control the black rot was carried on in the summer of 1907 in the Keuka Lake region. The work was done in the vineyard of Mr. S. C. Williams. Four rows in solid block and each forty rods long, were sprayed with Bordeaux, 5-5-50. Two adjoining rows in solid block were left unsprayed as checks. The plat was sprayed as follows:

May 10th, June 9th, June 28th, July 13th, (Bordeaux, 5-5-50), Aug. 7th, (Ammoniacal copper carbonate, 5-3-50.)

The rot was first discovered on the leaves June 28th. The spots were about one-eighth of an inch in diameter, and clearly defined, though

not numerous. The disease was first seen on the berries about July 10th. On July 13th, all the berries were picked from a sprayed and unsprayed vine and counted. Seventeen per cent had rotted on the sprayed vines, and twenty-seven per cent on the unsprayed. A slight epidemic appeared to have swept over the vineyard about this time. Following this, there was a period of dry weather and very little rot appeared. No other epidemic appeared during the season.



FIG. 187—*The bagging of grapes.*

The grapes were picked October 21st and 22d. A heavy frost occurred on the morning of October 21st. This did not interfere with picking or grading of the grapes. Records were made of the net yield as picked. The fruit was then taken to the packing house and graded. The weights of the commercial grade and the culls were then computed. The green grapes were placed in a grade by themselves. The results obtained were as follows:

	Total weight grapes lbs.	Weight com- mercial grade lbs.	Weight culls lbs.	Per cent commercial
Sprayed rows	1322	1291½	30½	97
Unsprayed rows	606	564½	41½	93

There were four rows of sprayed grapes, and two rows of unsprayed.

Of the 1291½ pounds of grapes from sprayed rows, there were 158 pounds that were sorted out and graded as green grapes. Mr. Williams stated that these would sell at ten dollars a ton. In a non-experimental plat these green grapes would have been left to ripen, and would probably have come in with the number one of commercial grade. There was a much smaller quantity of green grapes in the unsprayed lot, 41 pounds only in the total of 564½ pounds.

Bagging.

Growers think that enclosing the bunch in a sack soon after the fruit forms has several advantages:

- (a) Protection from mechanical injury.
- (b) Protection from frost.
- (c) Delays maturity or ripening.
- (d) Protection from rot.

The writer does not wish to discuss the first three. Plat 3 was planned in order to determine what protection from the rot a bag afforded the bunch. The results are marked. A portion of the plat was bagged immediately after the blossoms fell and before the appearance of the rot. The remainder was bagged about ten days later, which is as early as is practicable on a commercial scale. The results were determined by computing the per cent of bunches free from rot. Several hundred bunches were counted, and computations made in different parts of the plat. The results were in favor of the unbagged bunches. In the vineyard at Romulus (Niagara), an average of the different computations showed sixty-two per cent of the bagged bunches free from rot, and thirty-eight to contain rotten berries. Of the unbagged, seventy-six per cent were free from rot, and twenty-four contained rotten berries.

The vineyard at Penn Yan showed the same results, although fewer bunches were treated. Twelve clusters were bagged on the unsprayed rows, and every cluster carried from three to thirteen rotten berries. Forty clusters were bagged on the sprayed row, thirty-one of which were more or less rotted, and nine absolutely free from rot. By weight there were nine and one-half pounds of the bagged grapes. Of these two pounds were absolutely free from rot, while seven and one-half pounds carried a considerable number of rotten berries.

III. RECOMMENDATIONS FOR CONTROL OF BLACK-ROT

The most vulnerable point of attack is against the old mummies. If it is practicable, these should be gathered at picking time along with the gleanings, and after the separation in the packing house the whole rotted mass burned. In this way, great quantities of rot are removed and sources of infection for the next year destroyed.

In the spring, plow just as deeply as possible without disturbing the roots too seriously. Turn the ground completely over, thus burying the rotted berries three to six inches under the surface. Plow as near the vines as possible with a two-horse plow, and then use a one-horse plow to get nearer. Use a horse-hoe to turn the remaining debris and soil from under the rows into the furrow. Some mummies will remain on the surface even after such treatment, but each cultivation will cover up a few of these or at least disturb them and reduce their chances for maturing spores. Keep all weeds and grass down.

After trimming, there will be a few mummies left on the arms. The trimmers should be instructed to gather these and as opportunity affords burn them. All brush should be burned clean.

Never allow basal water-sprouts to spread out over the ground; they are prime centers of infection. Keep the vines off the ground.

A cover-crop of crimson clover, vetch or buckwheat, planted about the middle of July or earlier, is desirable.

Spray thoroughly: first, with Bordeaux mixture, 5-5-50, at the time when third or fourth leaf is showing; second, with the same mixture just when blossoms are swelling; third, with the same mixture soon after flowers have fallen.

The remaining applications will depend upon the weather. If the season is rainy, the applications should be made at intervals of ten days to two weeks; if dry, fewer applications will be necessary. Until July 20th use Bordeaux, 5-5-50; after this time use ammoniacal copper carbonate, 5-3-50. The latter solution will not discolor the grapes as Bordeaux mixture would. It is nearly as efficient as Bordeaux and perfectly harmless to the berries.

The spray should be put on at the rate of eighty to one hundred gallons to the acre, and under a pressure of at least one hundred pounds. The hole in the disc of the nozzle should be one-sixteenth inch.

Stationary nozzles may be used for the first two applications. When the fruit begins to form, use trailers and apply the spray directly on the berries.

FORMULAS.

Bordeaux Mixture.

Copper sulfate (blue vitriol) 5 lbs.
 Stone lime..... 5 "
 Water.....to make 50 gals.

Many methods are recommended for making the mixture. The following is handy and practical for the grape-grower:

Dissolve the copper sulfate crystals in water. Then pour the solution into the tank. Fill the tank about three-fourths full of water. Slake the lime in a pail or tub, applying hot water at first. Bring the lime to a thin milk. Strain this mixture into the spraying tank, and add water to make the mixture up to the required amount.

Ammoniacal Copper Carbonate.

Copper carbonate 5 oz.
 Ammonium 3 pts.
 Water.....to make 50 gals.

Dilute the ammonium with six or eight times its volume of water. Add the copper carbonate to the diluted solution, and stir until dissolved. Add water to make the required amount.

If large quantities of the above mixture are required, it is more economical for the grower himself to make the copper carbonate. Proceed as follows: Dissolve 12 pounds of copper sulfate (blue vitriol) in 12 gallons of water in a barrel. Dissolve 15 pounds of sal soda in 15 gallons of water (preferably hot). Allow the solution to cool; then add the sal soda solution to the copper sulfate solution, pouring slowly in order to prevent the mixture from working up and running over. A fine precipitate which will settle at the bottom after the mixture has stood about twelve hours is formed. Siphon off the clear liquid above. Wash the precipitate by adding clear water, stirring and again allowing to settle. Siphon off the clear water, strain the precipitate through muslin, and allow it to dry. This is copper carbonate. The above amounts will make about six pounds.